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Elucidating mineralisation-immobilisation dynamics in a grassland soil using triple 15N labelling in the field combined with a 15N tracing laboratory approach

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Mineralisation is a key N transformation process supplying reactive nitrogen (N) to terrestrial ecosystems. The various soil organic matter fractions contribute to the total mineralisation according to their turnover characteristic. However, the exact mechanism and the gross dynamics of the various processes are not well understood.
In this study we investigated the mineralisation-immobilisation dynamics in a grassland soil by a combined field-laboratory study. Eighteen micro-plots were established at a field site receiving 50 kg N ha-1 as ammonium nitrate. In nine (3 x 3) respective plots the ammonium, or the nitrate, or both moieties were 15N labelled at 60 atom%. Previous studies with this soil showed that rapid turnover occurred and available N would partly be immobilised by the microbial biomass increasing the 15N label of the soil organic nitrogen pool in the field. After one year, soil samples were taken from the 15N treated and the so far non-labelled plots and examined in a laboratory study (for details of the setup see: Müller et al., 2004). While the previously differentially 15N labelled field soils were now supplied with unlabelled ammonium nitrate, the previously unlabelled soils were now treated with either 15N labelled ammonium nitrate similar to the 15N treatments established in the field, resulting in six different 15N treatments in total. The incubation study was carried out over a two-week period and data were analysed with the Ntrace model to quantify the simultaneously occurring gross N transformations while optimizing a single parameter set for all six treatments. Thus, the appearance of 15N from the previously labelled soils and the dilution of the 15N in the recently labelled treatments were assumed to be driven by the same processes and activities and were used to constrain the 15N tracing model. This approach allowed us to estimate the individual gross N transformation rates with a much higher accuracy than if only a common triple labelling approach had been used. Here we present detailed gross N turnover dynamics and an improved conceptual model for the mineralisation-immobilisation dynamics in grassland soil.

Literature cited

Müller, C., Stevens, R.J., Laughlin, R.J., 2004. A 15N tracing model to analyse N transformations in old grassland soil. Soil Biology & Biochemistry 36, 619-632.